

WHAT IS CLAIMED IS:

1. A semiconductor device comprising:
a semiconductor substrate;
a field effect transistor provided on the semiconductor substrate and having electrodes, the transistor having a gate recess and a Schottky junction for a gate electrode; and
a pn junction diode provided on the semiconductor substrate and having electrodes, the pn junction diode having an n-type layer and a p-type layer; wherein
at least one of the electrodes of the field effect transistor and at least one of the electrodes of the pn junction diode are composed of metal conductors which are simultaneously formed.
2. The semiconductor device according to Claim 1, wherein a source electrode and a drain electrode of the field effect transistor and a cathode of the pn junction diode are composed of metal conductors which are simultaneously formed.
3. The semiconductor device according to Claim 1, wherein the gate electrode of the field effect transistor and an anode of the pn junction diode are composed of metal conductors which are simultaneously formed.
4. The semiconductor device according to Claim 1, wherein at least one of active layers of the field effect transistor and at least one of active layers of the diode are composed of layers which are obtained from a common active layer which is epitaxially grown.
5. The semiconductor device according to Claim 4, wherein contact layers of the field effect transistor and of the n-type layer of the pn junction diode are composed of layers which are obtained from a common n-type layer provided on the semiconductor substrate which is epitaxially grown.

6. The semiconductor device according to Claim 5, wherein the contact layers are provided on a channel layer on the semiconductor substrate of the field effect transistor, and the p-type layer of the pn junction diode is provided on the n-type layer thereof.

7. The semiconductor device according to Claim 4, wherein the active layer of the field effect transistor is separated from the active layer of the diode.

8. A semiconductor device comprising:
a semiconductor substrate;
a field effect transistor provided on the semiconductor substrate and having electrodes, the transistor having a gate recess and a Schottky junction for a gate electrode; and
a pn junction diode provided on the semiconductor substrate and having electrodes, the pn junction diode having an n-type layer and a p-type layer; wherein
a source electrode and a drain electrode of the field effect transistor and a cathode of the pn junction diode are composed of metal conductors which are simultaneously formed; and
the gate electrode of the field effect transistor and an anode of the pn junction diode are composed of metal conductors which are simultaneously formed.

9. The semiconductor device according to Claim 8, wherein at least one of the electrodes of the field effect transistor and at least one of the electrodes of the pn junction diode are composed of metal conductors which are simultaneously formed.

10. The semiconductor device according to Claim 8, wherein at least one of active layers of the field effect transistor and at least one of active layers of the diode are composed of layers which are obtained from a common active layer which is epitaxially grown.

11. The semiconductor device according to Claim 10, wherein contact layers of the field effect transistor and of the n-type layer of the pn junction diode are composed of layers which are obtained from a common n-type layer provided on the semiconductor substrate which is epitaxially grown.

12. The semiconductor device according to Claim 11, wherein the contact layers are provided on a channel layer on the semiconductor substrate of the field effect transistor, and the p-type layer of the pn junction diode is provided on the n-type layer thereof.

13. The semiconductor device according to Claim 10, wherein the active layer of the field effect transistor is separated from the active layer of the diode.

14. A method for manufacturing a semiconductor device including a semiconductor substrate, a field effect transistor provided on the semiconductor substrate and having a gate recess and a Schottky junction for a gate electrode, and a pn junction diode provided on the semiconductor substrate, the method comprising:

- a step of preparing the semiconductor substrate;

- a step of forming a channel layer for the field effect transistor, a first etching stopper layer, an n-type common layer used for contact layers for the field effect transistor and for an n-type layer for the diode, a second etching stopper layer, a p-type layer for the diode, and a third etching stopper layer on the semiconductor substrate in that order by epitaxial growth;

- an etching step of etching away the p-type layer and the third etching stopper layer in regions in which the field effect transistor and a cathode of the diode are to be formed so that the etching is to be stopped by the second etching stopper layer;

- a step of simultaneously forming a source electrode and a drain electrode for the field effect transistor and the cathode for the diode so as to have an ohmic contact with the n-type common layer;

a step of forming a mask having openings which expose a region of the n-type common layer in which the gate recess for the field effect transistor is to be formed and at least a portion of the third etching stopper layer;

a step of performing etching through the mask for forming the gate recess in the n-type common layer while the third etching stopper layer prevents the p-type layer from being etched, in which the etching is stopped by the first etching stopper layer;

a step of simultaneously forming the gate electrode for the field effect transistor which has a Schottky contact with the channel layer and an anode for the diode which has an ohmic contact with the p-type layer through the mask; and

a step of removing the mask.

15. The method for manufacturing a semiconductor device, according to Claim 14, further comprising, after the etching step:

performing etching or ion implantation for the channel layer and the n-type common layer in order to separate a region in which the field effect transistor is to be formed from a region in which the diode is to be formed.

16. The method for manufacturing a semiconductor device, according to Claim 14, wherein the third etching stopper layer is formed to have a thickness that is larger than a total thickness of the first and the second etching stopper layers.